Science Overview

FINESSE will revolutionize our understanding of exoplanet atmospheres by spectroscopically surveying 500 planets outside of our Solar System, ranging from terrestrials with extended atmospheres to sub-Neptunes to gas giants. FINESSE's broad, instantaneous spectral coverage and survey capability enable exploration of TESS discoveries and will provide a framework for interpreting detailed JWST observations. The FINESSE survey will yield transformative knowledge about the extended planet family by discovering what these alien worlds are like, determining what makes them they way they are, and allowing this knowledge to be applied in the broader planetary context, including the search for life outside of our Solar System.

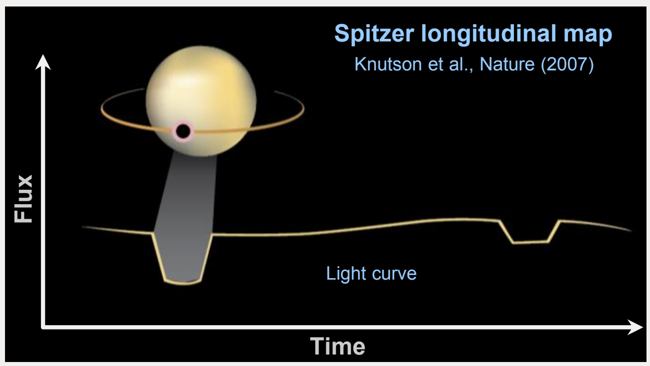
Science Objectives

FINESSE directly addresses NASA's science objective to "Generate a census of extra-solar planets and measure their properties." FINESSE will:

1. **Determine key aspects of the planet formation process.** FINESSE will obtain the atmospheric composition measurements of metallicity and carbon-to-oxygen ratio that are needed to address all future efforts to understand planet origins. Through these measurements we will discover whether our Solar System formation was typical or exceptional.
2. **Reveal the crucial factors that establish planetary climate.** FINESSE measurements will determine planetary energy budgets, the role of aerosols (clouds and hazes) in establishing the atmospheric radiation balance, and the processes that control heat redistribution from the dayside to the nightside.

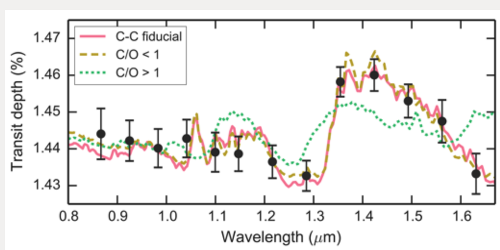
Measurement Technique

- During a transit, light from the parent star filters through the planet's atmosphere, encoding molecular features.
- FINESSE obtains a spectrum by measuring how light at each wavelength changes during a transit.
- This proven technique is extended to measure light curve changes during the planet's orbit using observations spaced between transit and eclipse; this approach maps emission as a function of longitude on the exoplanet.



Hubble detection of water

Kreidberg, Bean, Line et al., Astrophysical Journal (2015)



FINESSE will measure hundreds of exoplanet spectra using proven techniques pioneered by the FINESSE science team.

Mission Overview

- Earth-Sun L2 (Heliocentric) orbit
- 2016 MIDEX Standard LV compatible
- Near-unrestricted launch period (better than 95% launch availability)
- DSN stations for downlink (one eight-hour pass/week during Science Operations)
- Two-year Baseline Science Mission duration
- Full-sky coverage every four months

Payload

- Telescope, 75 cm Cassegrain
  - All-aluminum, IR surface figure
  - Passively cooled to 125 K
- Spectrometer, 0.5–5.0 μm,
  - $\lambda/\Delta\lambda \cong 80$ @ 1.2 μm, 300 @ 3 μm
  - Passively cooled to 90 K
  - Single observing mode, high stability
- Payload in the loop fine guidance
  - Integrated with spectrometer
  - Uses separate window on science detector for guiding
- Single detector, HgCdTe, JWST/NIRSpec copy
  - Passively cooled to 70 K

Partners

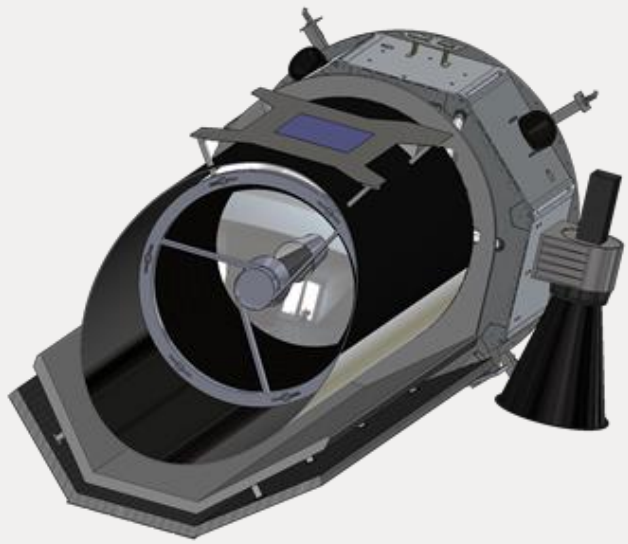
- JPL: PI institution, Spectrometer and Spectrometer I&T, Project Management, Mission Design, and MOS & GDS
- Ball Aerospace: Spacecraft and ATLO
- L-3 SSG: Telescope, OBA and Payload I&T
- Teledyne: Focal Plane Array
- IPAC: Science Data Archive

Co-Investigators

Jacob Bean (U of Chicago), Nicolas Cowan (McGill), Jonathan Fortney (UC Santa Cruz), Robert Green (JPL), Caitlin Griffith (U of Arizona LPL), Eliza Kempton (Grinnell), David Latham (Harvard/CfA), Michael Line (ASU), Suvrath Mahadevan (Penn State), Jorge Melendez (U of Sao Paulo), Julianne Moses (SSI), Adam Showman (U of Arizona LPL), Gautam Vasisht (JPL), Edward Wright (UCLA)

Spacecraft

- Ball small bus product line (ATPsat, WISE)
- 3-axis stabilized S/C
- Mono-propellant hydrazine propulsion
- S-band downlink
- Integrated solar array/Sun shield/cold shield passively cool the payload
- No deployable elements



Parameter	Design w/cont.	Capability	Margin (%)
Launch Mass (kg)	618	1500*	143
Power (W)**	248	455 (EOL)	84
Downlink Time (h/wk)	4.7	7	50
Data Storage (GB)	4.2	12	186

** AO Standard ELV* *** Sci Ops*

Mission Cost Estimates

	FY17$M	RY$M
PI-Managed Mission Cost	249.9	285.7
Co-I contributions (McGill, U of Sao Paulo)	1.1	1.4
Collaborator contributions (Harvard, ASU, STScI, Caltech)	0.3	0.3
Total Mission Cost	251.3	287.4

Note: Costs include reserves of 32% in Phases B/C/D and 15% in Phase E/F; total reserves of 30%.